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**XCOR comments on:**

**Draft Guidelines for Commercial Suborbital Reusable Launch Vehicle Operations with Space Flight Participants (February 11, 2005)**

FAA has written a useful guideline for RLV operations with space flight participants. XCOR has some comments for its improvement.

**5. Definitions**

**Flight crew**

XCOR commented extensively on FAA's draft definition of "flight crew" in our comments on FAA's Draft Guidelines for Commercial Suborbital Reusable Launch Vehicle Operations with Flight Crew, also published on February 11, 2005. To summarize our comments, XCOR believes that "flight crew" should be defined in reference to their mission to ensure public safety, not merely their employment by the vehicle operator and their presence aboard the vehicle.

**6. Risk Communication**

Guideline 6.a.(1) recommends that the operator disclose to the space flight participant known hazards and risks, in writing, including both nominal and non-nominal operations. XCOR agrees with all that FAA says in the guideline, but FAA's language is too arcane. The language used to communicate the risk to the space flight participant should be clear, concise, and unambiguous. It should include the vehicle's reliability expressed as a percentage. It should also include the space flight participant's likelihood of death, expressed as a percentage and as odds against. Example: "You have a 10% chance of dying on this flight. Put another way, the odds of your dying on this flight are 10 to 1 against."

The rationale for this guideline also contains a noun error and an error in tense. The last sentence of the rationale reads, "*Presenting the information in a manner that is*

*understandable to the space flight participant helps the space flight participant make an informed decision on whether to be on board a launch or reentry vehicle.*” The noun error is small but easily repairable; “launch,” by itself, is a noun, usually describing a type of small boat. The phrase “*launch or reentry vehicle*” can thus be read to mean “small boat or returning space vehicle.” It is clear from context that FAA means “launch vehicle or reentry vehicle,” and we suggest that FAA use that phrase.

The tense error in this sentence is more serious, and concerns the phrase “*be on board a...vehicle.*” The time for the space flight participant to make an informed decision about being on board the vehicle is before he or she boards. The decision, then, is not whether to **be** on board but whether to **get** aboard. This is a small distinction by itself, but the language in the rationale suggests the possibility that a space flight participant might decide not to be aboard when he or she is already aboard. This in turn suggests the possibility of unilateral action by the space flight participant to exit the vehicle, which action has a slight potential to put the uninvolved public at risk (e.g. space flight participant panics, jettisons the canopy, and bails out – the canopy becomes uncontrolled debris).

The space flight participant should be offered several opportunities to reverse their decision to board the vehicle, though we offer that as an example of good industry practice, not as a suggested FAA guideline. Once the space flight participant has boarded the vehicle, and the vehicle has been sealed for launch, the vehicle operator will be primarily concerned with the safety of the uninvolved public. Deviations from licensed launch procedures will not be made lightly, and would only be justified in the event of genuine distress of the space flight participant, or if the space flight participant announces that he has reversed his decision and revoked his consent, and he no longer wishes to participate in a space flight. (If he does that after we push off, we’re keeping his money.)

#### **6.a.(2) Vehicle Safety Records**

Guideline 6.a.(2) recommends that the operator describe to each space flight participant the safety records of all manned vehicles, not just its own, including both U.S. government and private sector vehicles. XCOR endorses this recommendation with enthusiasm, as it allows the space flight participant to make the best possible informed decision.

XCOR notes that FAA will have to provide this information to all RLV operators, both to ensure uniformity across operators and to avoid conflicts of interest between operators. This should not pose a problem, as FAA will have access to all accident data and reportable incident data by private sector operators as part of its oversight authority, and should be able to obtain from NASA what incident data is not already in the public record (all NASA accident data is already in the public record).

XCOR suggests two changes to language in the rationale for this guideline. The first change is to the sentence, “*because most human space flight to date has taken place under government auspices, the government safety record provides the most data,*” approximately in the middle of the paragraph. XCOR notes that private sector flight rates will probably be higher than government flight rates in the near future, and so this sentence will become

inaccurate in a few years. XCOR suggests that the word “currently” be inserted between “record” and “provides.” The sentence would then read, “*because most human space flight to date has taken place under government auspices, the government safety record currently provides the most data.*”

The second change is to the clause, “*those persons traveled on vehicles based on technology as new then as what may be developed now.*” That clause is confusing. XCOR suggests instead, “*those people traveled on new and unproven vehicles. While past space vehicles were designed with different technology and missions than RLVs, they represented the results of well-funded efforts using the best technology of their era, and they therefore provide a relevant basis for comparative risk.*” The last two sentences of the rationale would then be redundant, and should be stricken.

## **11. Security**

FAA recommends that “*the RLV operator should implement security requirements to prevent any space flight participant from jeopardizing the safety of the crew, any other space flight participant on board, and the uninvolved public.*” XCOR strongly agrees with the first and third parts of this guideline, but we strongly disagree with the second. FAA’s dual mission is to promote the space flight industry and to protect the uninvolved public. FAA has no authority to protect space flight participants, who are not members of the uninvolved public.

The first part of this guideline, “*prevent any space flight participants from jeopardizing the safety of the crew,*” is a legitimate part of FAA’s public safety mission, since the proper performance of the crew can directly affect the safety of the uninvolved public. Similarly, the third part of this guideline, “*prevent any space flight participant from jeopardizing the safety of...the uninvolved public,*” also clearly falls under FAA’s purview to ensure public safety.

However, the second part of this guideline, “*prevent any space flight participant from jeopardizing the safety of any other space flight participant on board,*” is not within FAA’s authority as a regulatory agency. FAA does not have the statutory authority to regulate the safety of anyone except the uninvolved public. FAA must withdraw the second part of this guideline.

The third part of this guideline contains a grammatical error. Striking the second part, this guideline reads, “*...prevent any space flight participant from jeopardizing the safety of the crew and the uninvolved public.*” If a space flight participant jeopardized the safety of the crew, or the uninvolved public, but not both, the RLV operator would have satisfied this guideline as it is currently written. To meet the intent of this guideline, the “and” must be changed to an “or.”

XCOR agrees that the space flight participant should be prevented from endangering the flight crew, but we do not view that as a security requirement. We view it as a public safety requirement, and we build it into the vehicle. There will be nothing a space flight participant can do to affect the safety of the flight crew.

XCOR already has in place plans to prevent space flight participants from interfering with flight crew during a flight; they amount to physical separation of the flight crew and the space flight participant. We also have plans to prevent the space flight participant from inadvertently interfering with safety critical ground crew; these are the standard safety precautions every prudent operator exercises in flight operations. The essence of these precautions is that no unauthorized person is permitted near the vehicle while it is in service.

To prevent the space flight participant from interfering with non-safety critical ground crew - gate agents and the like - we will rely on a virtue of the space flight participant population: self-interest. We will make clear to all space flight participants during training that any activity that places another person at risk - including such security violations as carrying explosives or brandishing firearms, knives, or other weapons - is grounds for immediate revocation of their privilege to participate in a space flight.

In the aftermath of September 11<sup>th</sup>, anyone who thinks about aviation security thinks about the scenario of a suicidal hijacker seizing control of an airplane and performing a *kamikaze* attack on a large group of people. We have considered that scenario. Of the three people we have identified as prospective pilots of XCOR RLVs, two are combat veterans and the third is a fighter pilot. None of these men would voluntarily accede to a hijacker's demands, and there is no available physical means for a hijacker to enforce his demands on a pilot; the space flight participant and the pilot are in separate compartments.

This leaves only theft of the RLV by a space flight participant as a security threat. A horizontal takeoff, horizontal landing RLV is like an airplane in many ways, and a skilled, trained airplane pilot can fly an RLV. A skilled, untrained pilot would find it difficult to fly an RLV. An unskilled, untrained pilot would find it impossible to fly an RLV at all, much less fly it into a ground target. Theft by an unskilled, untrained pilot masquerading as a space flight participant is thus not a credible security threat.

Finally, XCOR notes that the security precautions exercised by GA pilots in screening their passengers have resulted in a general aviation security environment that is completely unremarkable. General aviation security is a non-issue; what threats exist are being mitigated by the GA community without noticeable effort.

## **12. Verification Program**

FAA recommends that that an RLV operator or developer conduct a verification program, including flight testing, before flying any space flight participant. XCOR concurs enthusiastically with this recommendation. However, the rationale for this guideline needs work.

The rationale for this guideline includes an extensive discussion of risk, and how flight testing both mitigates that risk and quantifies it. But risk to whom or to what? To the space flight participant? To the uninvolved public? To the vehicle? To the flight crew? The answer is all of the above. However, FAA is only authorized to assure the safety of the

uninvolved public. Assuring the safety of the flight crew is beyond the scope of FAA's direct authority, as is assuring the safety of the space flight participant. Mission assurance is right out.

Validation and Verification (V&V) is valuable, and it does help ensure the safety of the uninvolved public. However, using V&V to ensure the safety of the uninvolved public is not in scope for a guideline on space flight participants.

What role, then, does V&V – including flight test – play in the regulation of space flight participants? The answer is that flight test plays an integral role in the provision of informed consent. Without a flight test plan, and some number of test flights, the RLV operator cannot provide the space flight participant with a valid number for demonstrated reliability. If the RLV operator cannot provide a valid number for demonstrated reliability, then the space flight participant cannot give informed consent, and the RLV operator cannot fly the space flight participant.

XCOR suggests that FAA rewrite the rationale for this guideline to emphasize informed consent, rather than risk mitigation.

### **Summary**

FAA has written a well rounded set of draft guidelines for space flight participants, which draft guidelines address the relevant issue and assure the safety of uninvolved public, without placing an undue burden on the RLV industry. The sole exception to this is the guideline on space flight participant security, which needs to be rethought with the understanding that space flight participants will number in the hundreds, not the hundreds of millions; will have paid a great deal and worked hard to be where they are; and will be a self-selected group of fit, wealthy, highly enthusiastic people each of whom will be strongly motivated to ensure that their flight is a success. This group of people will present very little security risk, and what little security risk they present will be easily manageable.

XCOR appreciates this opportunity to comment on the RLV space flight participant draft guidelines. We again commend FAA on not using the word "shall" in these guidelines, and we look forward to seeing the next revision of the RLV space flight participant guidelines.

Sincerely,

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